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(54) A METHOD OF PREPARING AN ANTI-FRICTION MATERIAL

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The present invention relates to a method of preparing an antifriction material.

Said materials are useful for the production of friction couple elements such as sealing rings, thrust bearings, supporting journals, sliding bearings for electric motors as employed in oil wells; chemical equipment such as centrifuges and pumps for corrosive liquids, e.g. acids, kerosene, petroleum, oils, salt solutions, alkali solutions, and other liquids which are corrosive at elevated temperatures.

Known in the art is an antifriction material containing silicon carbide and carbon; this antifriction material is prepared using carbonaceous materials as the starting components.

As a starting component for the production of said known material use is made of a graphite blank which is treated with silicon oxide vapours at a temperature of from 1,600 to 2,200°C. The silicon oxide vapours are evolved from silicon oxide atomized in a hydrogen current. The use of a reducing atmosphere and elevated temperatures contributes to the formation of silicon vapours and interaction thereof with graphite. As a consequence, silicon carbide is formed which, being deposited on the graphite surface, produces a superficial layer.

A material is thus obtained which contains silicon carbide and graphite. Such material, however, has some essential disadvantages. First of all, it possesses different thermal expansion coefficients of graphite and silicon carbide, which results in the formation of cracks either in the graphite or in the silicon carbide during temperature variations. Therefore, when this known material is employed under oxidizing conditions in the presence of an oxidizing medium at temperatures of from 300 to 600°C, it is liable to break down, since such medium penetrates into cracks and destroys graphite disposed under the silicon carbide layer, whereby the antifriction properties of the whole material are impaired.

Moreover, the complete lack of graphite possessing lubricating properties in the superficial layer of the material results in an increased coefficient of friction, whereby the antifriction properties of the material to be obtained are also deteriorated.

It is an object of the present invention to obviate or mitigate the disadvantages of the aforesaid antifriction materials.

According to the present invention there is provided a method of preparing an antifriction material, comprising forming a mixture of carbon and a binder, compressing the mixture at a temperature within the range from 150 to 180°C to produce a blank having a density of 1 to 1.4 g/cm³, heating the blank at a temperature within the range from 800 to 1000°C, and impregnating the heated blank with silicon at a temperature within the range from 1700 to 2050°C.

This antifriction material produced by the present method is stable under frequent heat variations and retains its properties under oxidation conditions at elevated temperatures.

Preferably the binder is thermosetting resin.

Preferably the carbon is selected from graphite powder, carbon black, carbon fibres or mixtures thereof.

In order to completely remove gas from the pores of the material being obtained,

it is preferred that impregnation with silicon be performed in vacuum.

In order to increase the plasticity of the material being obtained, the impregnation with silicon may be effected in the presence of nickel, cobalt, zirconium, niobium, titanium, molybdenum, tungsten, tantalum or chromium, taken separately or in admixture.

It is advantageous, that during the mixing of the above carbon materials with the binder, iron and aluminium be mixed thereto either separately or in admixture.

The present invention will be better understood from the following detailed description of a specific example of an embodiment.

An antifriction material comprising silicon carbide in an amount of from 20 to 65% by weight, carbon in an amount of from 75 to 10% by weight, and silicon in an amount of from 5 to 25% by weight is prepared from the starting components as follows; as such components use may be made of carbon containing materials selected from graphite powder, carbon black and carbon fibers. Said materials may be employed both separately and in admixture with each other.

When graphite powder is used the antifriction properties of the material being prepared is increased; when carbon black is used the silicon carbide content in the material being prepared is increased and this enhances its wear-resistance and when carbon fibers are introduced the resilience of the material is increased.

The starting carbon containing materials are mixed with a binder selected from the group of thermosetting resins such as phenol-formaldehyde resins possessing a property of softening upon heating over 100°C and of wetting carbon particles, thus imparting necessary plasticity of the whole composition.

The mixture of carbon and binder is compressed at a temperature within the range from 150 to 180°C to form a plasticized blank which is further compressed until its density becomes 1.0 to 1.4 g/cm³.

As a consequence, a porous carbon containing material is obtained and its pores are then filled with silicon. A density of less than 1.0 g/cm³ results in the production of a carbon material possessing rather low strength for the subsequent impregnation with silicon. The use of a density of above 1.4 g/cm³ causes a decrease in the amount of pores and, hence, an incomplete impregnation of the material with silicon.

The resulting blank with the above-mentioned density is then heat-treated according to the following scheme: first calcined in an inert atmosphere at a temperature from 800 to 1,000°C and then impregnated with molten silicon at a temperature of from 1,700 to 2,050°C.

The carbon containing blank may be impregnated in vacuum. In doing so, gases are removed from the pores of the material being treated, and the impregnation proceeds more intensively.

However, the siliconizing of a carbon containing blank may be also performed in an inert atmosphere, but in this case a material is produced which has a somewhat lower silicon carbide content.

During the intermixing of the carbon containing material and the binder, powders of iron and/or aluminium may be added to the mixture in such a manner that their respective content in the final material is up to 3% by weight.

Iron facilitates the impregnation of porous graphite with silicon, while aluminium contributes to the densification of the carbide phase, thus resulting in the production of a gas-impermeable material.

Said additives may be incorporated into the composition either simultaneously or separately.

For a better understanding of the present invention some specific examples of its embodiment are given hereinbelow.

EXAMPLE 1

A powder of artificial graphite having fineness 0—1.25 mm is mixed with a phenol-formaldehyde resin the components being taken in the proportions of 85 and 15% by weight respectively. The resulting mixture is compressed, upon heating at 150°C and under the pressure of 120 kg/cm², to a blank with the density of 1.25 g/cm³ which is then calcined in an inert atmosphere at a temperature of 800°C. The calcined blank is subjected to a high-temperature treatment in molten silicon at a temperature of 2,050°C. The resulting material has the following composition:

silicon carbide	25% by weight;
graphite	50% by weight;
free silicon	25% by weight.

The material thus prepared has the following properties:

density	2.25 g/cm³;
ultimate compression strength	1,300 kg/cm²;
ultimate bending strength	700 kg/cm²;
coefficient of friction	0.05;
resilience	2 kgf.cm/cm².

EXAMPLE 2

A powder of graphite having fineness of 0—0.2 mm. is mixed with a phenol-formaldehyde resin, the components being em-

ployed in the proportions of 85 to 15% by weight respectively. The resulting mixture is compressed at a temperature of 160°C to a blank with a density of 1.20 g/cm³ which is then calcined in an inert atmosphere at the temperature of 900°C, treated in molten silicon at the temperature of 1,750°C. The resulting material has the following composition:

silicon carbide	65% by weight;
graphite	28% by weight;
free silicon	7% by weight.

The material has the following properties:

density	2.55 g/cm³;
ultimate compression strength	3,000kg/cm²;
ultimate bending strength	900 kg/cm²;
coefficient of friction	0.05;
resilience	2.8 kgf.cm/cm².

EXAMPLE 3

A composition prepared by mixing graphite powder with a fineness of 0 to 0.5 mm. with a phenol-formaldehyde resin in proportions of 85 and 15% by weight respectively, is compressed at the temperature of 170°C and under the pressure of 200 kg/cm² to a blank having a density of 1.3 g/cm³ which is calcined in an inert atmosphere at the temperature of 900°C. The resulting blank is treated in molten silicon at the temperature of 1,800°C.

The material thus prepared has the following composition:

silicon carbide	47% by weight;
graphite	48% by weight;
free silicon	5% by weight.

and has the following properties:

density	2.40 g/cm³;
ultimate compression strength	3,200 kg/cm²;
ultimate bending strength	900 kg/cm²;
coefficient of friction	0.05;
resilience	2.8 kgf.cm/cm².

EXAMPLE 4

Graphite powder having fineness of 0—0.5 mm. and iron powder having fineness of 0—0.05 mm. are thoroughly mixed with a phenol-formaldehyde resin in proportions of 82, 3 and 15% by weight respectively. The resulting mixture is compressed at a temperature of 150°C and under a pressure of 150 kg/cm² into a blank with a density of 1.4 g/cm³ which is further calcined in an inert atmosphere at a temperature of 900°C. Then the blank is treated in molten silicon at a temperature of 1,700 C. The resulting material has the following composition:

silicon carbide	71% by weight;
graphite	24% by weight;
free silicon	5% by weight.

and has the following properties:

density	2.70 g/cm³;
ultimate compression strength	4,200 kg/cm²;
ultimate bending strength	1,000 kg/cm²;
coefficient of friction	0.05;
resilience	3.2 kg.cm/cm².

EXAMPLE 5

Graphite powder having fineness of 0—0.5 mm. and aluminium powder having fineness of 0—0.05 mm. are mixed with a phenol-formaldehyde resin in weight proportions of 82, 3 and 15% respectively.

The resulting mixture is compressed at a temperature of 150°C and under a pressure of 200 kg/cm² into a blank having a density of 1 to 1.4 g/cm³ and the blank is calcined in an inert atmosphere at a temperature of 900°C. The blank is then treated in molten silicon at a temperature of 2,050°C. The material thus prepared has the following composition:

silicon carbide	72% by weight;
graphite	25% by weight;
free silicon	3% by weight,

and has the following properties:

density	2.70 g/cm³;
ultimate compression strength	4,500 kg/cm²;
ultimate bending strength	1,200 kg/cm²;
coefficient of friction	0.04;
resilience	4 kgf.cm/cm².

EXAMPLE 6

Graphite powder having fineness of 0—0.5 mm. is mixed with carbon black and a phenol-formaldehyde resin in weight proportions: graphite, 75%; carbon black, 10%; and phenol-formaldehyde resin, 15%. The resulting mixture is compressed at a temperature of 150°C and under a pressure of 300 kg/cm² into a blank having a density of 1 to 1.4 g/cm³ and the blank is calcined in an inert atmosphere at a temperature of 900°C. Cylindrical samples made of this blank are siliconized at a temperature of 2,050°C. The resulting material has the following composition:

silicon carbide	71.3% by weight;
graphite	22.8% by weight;
free silicon	5.9% by weight,

and features the following properties:

density	2.70 g/cm³;
ultimate compression strength	4,300 kg/cm²;
ultimate bending strength	1,100kg/cm²;
coefficient of friction	0.04.

EXAMPLE 7

A powder of artificial graphite with a fineness of 0—0.315 mm., carbon fibres, and a phenol-formaldehyde resin taken in weight proportions: graphite, 80%; carbon fibres, 5%; and resin 15%, are thoroughly intermixed. The resulting mixture is compressed at a temperature of 150°C and under a pressure of 100 kg/cm² into samples having a density of 1 to 1.4 g/cm³ and dimensions (cross-section): 10 × 10 mm., and 120 mm. long. Compressed samples are calcined at a temperature of 900°C and then siliconized at a temperature of 2,050°C. The samples are thereafter tested for resilience. The presence of fibers in the samples has improved their resilience by three times as compared to similar samples made of the known material. During the tests the following properties have been shown:

density	2.45 g/cm³;
ultimate compression strength	4,000 kg/cm²;
ultimate bending strength	1,000 kg/cm²;
coefficient of friction	0.05;
resilience	10 kgf.cm/cm².

EXAMPLE 8

Graphite powder with a fineness of 0—0.315 mm., carbon fibres and a phenol-formaldehyde resin taken in weight proportions; graphite, 70%; carbon fibre, 15%; resin, 15% are thoroughly intermixed. The resulting mixture is compressed at a temperature of 180°C and under a pressure of 50 kg/cm² into samples having a density of 1 to 1.4 g/cm³ and dimensions: 10 × 10 × 120 mm.. The compressed samples are calcined at a temperature of 900°C and then impregnated with an alloy containing 75% by weight of silicon and 25% by weight of nickel at a temperature within the range from 1700 to 2050°C. The samples are thereafter tested for resilience. The resilience is 12 kgf.cm/cm².

WHAT WE CLAIM IS:—

1. A method of preparing an antifriction material, comprising forming a mixture of carbon and a binder, compressing the mixture at a temperature within the range from 150 to 180°C to produce a blank having a density of 1 to 1.4 g/cm³, heating the blank at a temperature within the range from 800 to 1000°C, and impregnating the heated blank with silicon at a temperature within the range from 1700 to 2050°C.

2. A method as claimed in claim 1, wherein impregnation is effected in a vacuum.

3. A method as claimed in any one of the preceding claims, wherein the carbon is selected from graphite powder, carbon black, carbon fibres or mixtures thereof.

4. A method as claimed in any one of the preceding claims, wherein the impregnation with silicon is effected in the presence of nickel, cobalt, zirconium, niobium, titanium, molybdenum, tungsten, tantalum, or chromium, or mixtures thereof.

5. A method as claimed in any one of the preceding claims, wherein aluminium and/or iron is added to the mixture during mixing.

6. A method of producing an antifriction material according to claim 1, substantially as hereinbefore described and with reference to any one of the Examples.

7. An antifriction material whenever prepared by the method claimed in any one of claims 1 to 6.

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